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DIGITIZING TOPOGRAPHIC DATA FOR SKYLINE DESIGN PROGRAMS

by

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ABSTRACT

Presents a procedure for digitizing skyline road topographic data from stereo-aerial photographs. A Kelsh-type stereoplotter and digital scaler are used to prepare computer data cards. Will be helpful to the designer who uses large digital computers for skyline road design.

1.0 INTRODUCTION

Several computer programs have been or are being written to aid forest engineers in the layout of skyline logging shows.[2] These skyline design programs were developed to compute load-carrying capability under a variety of topographic conditions and equipment. Collecting topographic data from the ground, contour maps, or photos requires a significant effort when several skyline roads are involved. This note discusses a procedure for the collection of topographic data from stereophotographs through use of a Kelsh-type stereoplotter[3] and a digital scaler or digitizer. The operator procedures and card formats are presented to insure compatibility between computer program input and the stereoplotter digitizer output.

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[2] Skyline design programs SKY16 and RSKY, written by the Forest Engineering Project, Pacific Northwest Forest and Range Experiment Station, Seattle, Wash. These programs are written in Fortran IV and are presently operational on the CDC 3100 computing facilities in main office, USDA Forest Service, Region 6, Portland, Oreg.

Briefly, the skyline designer prepares equipment information and specific road descriptions on photographs. The stereoplotter operator, through use of the digitizer and keypunch, takes terrain point data directly from the stereophotograph model and prepares data cards describing each skyline road. The format of these cards is compatible with the skyline design programs and is ready for direct use. The purpose of this note is to discuss the responsibilities of the designer, plotter operator, and data processing personnel in the total procedure for digitizing the skyline design information. The following sections discuss separately the responsibilities of each of these individuals.

2.0 PREPARATION OF DATA--DESIGNER

The procedures for planning a skyline sale are discussed by Binkley and Lysons in "Planning Single-Span Skylines."[4] The designer must provide equipment information and geometric data for each skyline road. The geometric data include the height and location of the headspar and tailspar, the location of the inner and outer yarding limits, the carriage ground clearance, and the terrain profile data.

The information must be submitted in a format that will be accepted by the stereoplotter and the skyline design programs. The title data, equipment data, height of headspar and tailspar, and clearance are submitted on the forms illustrated in figure 1 for the standing skyline and figure 2 for the running skyline. The input form is accompanied by aerial photographs with the skyline roads delineated (fig. 3).

The input data for both skyline design programs are basically the same. The numbers in the upper right-hand corner of each block on the input form indicate the column number on the data card. For example, there are 70 spaces allowed for the project title and 10 spaces for the date.

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[3] Mention of products by name does not constitute endorsement by the U.S. Department of Agriculture.

[4] Virgil W. Binkley and Hilton H. Lysons. Planning single-span skylines. Pacific Northwest Forest & Range Exp. Sta. USDA Forest Serv. Res. Pap. PNW-66, 10 pp., illus. 1968.

STANDING SKYLINE

Project title: 70							Date: 80
Region: 10	Forest: 30		District: 50		Location: 80		
EQUIPMENT DATA							
SKYLINE			MAIN LINE				
Cable diameter	Cable weight	Breaking strength	Cable diameter	Cable weight	Breaking strength	Safety factor	Carriage weight
10 xx.xx	20 xxx.xx	30 xxxxxx.xx	40 xx.xx	50 xx.xx	60 xxxxxx.xx	70 x.xx	80 xxxx.xx
.	.	.	.	.	.	.	.
Number of skyline roads 25			Number of critical points to be examined on each skyline road 60			Format of geometric input data 80	

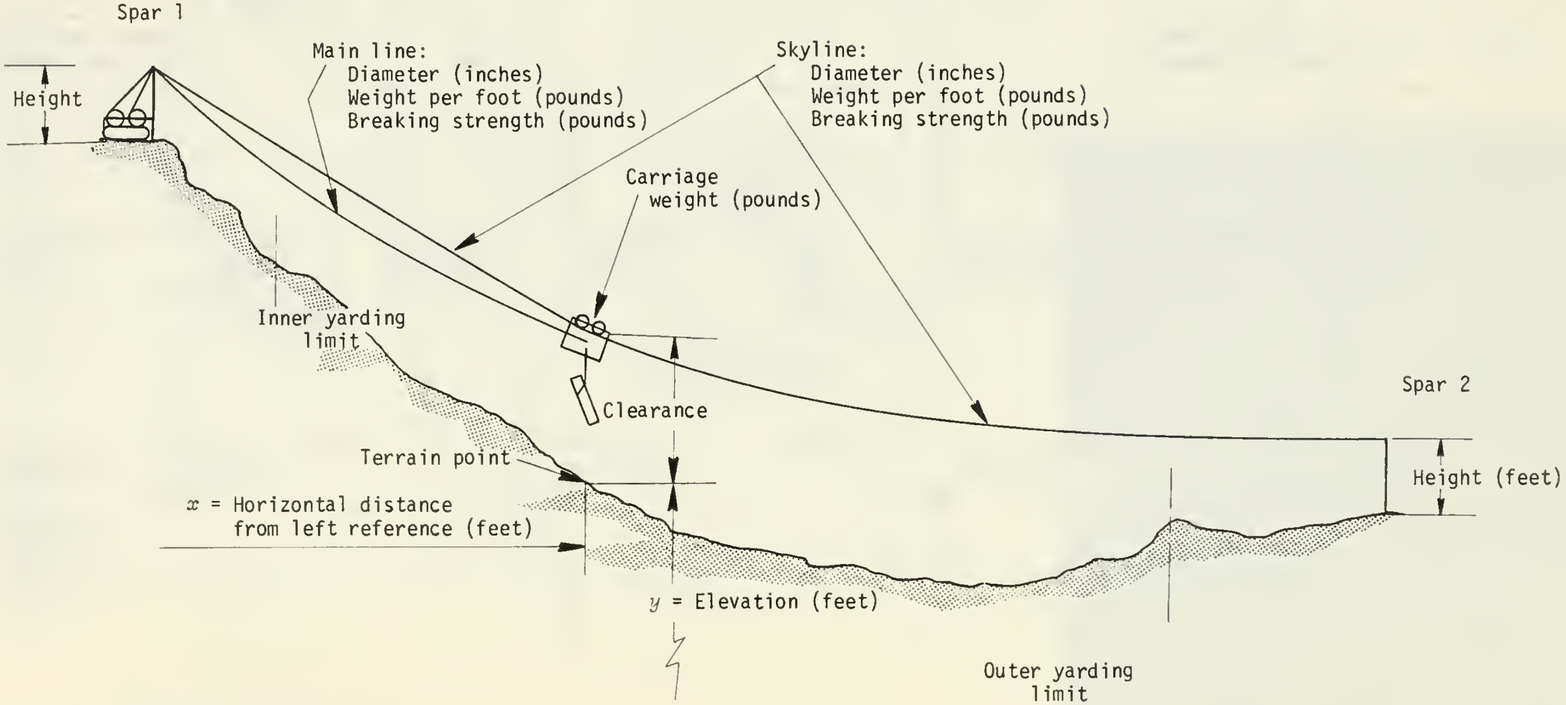


Figure 1.—Standing skyline.

RUNNING SKYLINE

Project title:			70	Date: 80
Region: 10	Forest: 30	District: 50	Location: 80	

EQUIPMENT DATA

HAULBACK			MAIN LINE				
Cable diameter	Cable weight	Breaking strength	Cable diameter	Cable weight	Breaking strength	Safety factor	Carriage weight
10 xx.xx	20 xxx.xx	30 xxxxxx.xx	40 xx.xx	50 xx.xx	60 xxxxxx.xx	70 x.xx	80 xxxx.xx
.	.	.	.	.	.	.	.
Number of skyline roads 25						Format of geometric input data 80	

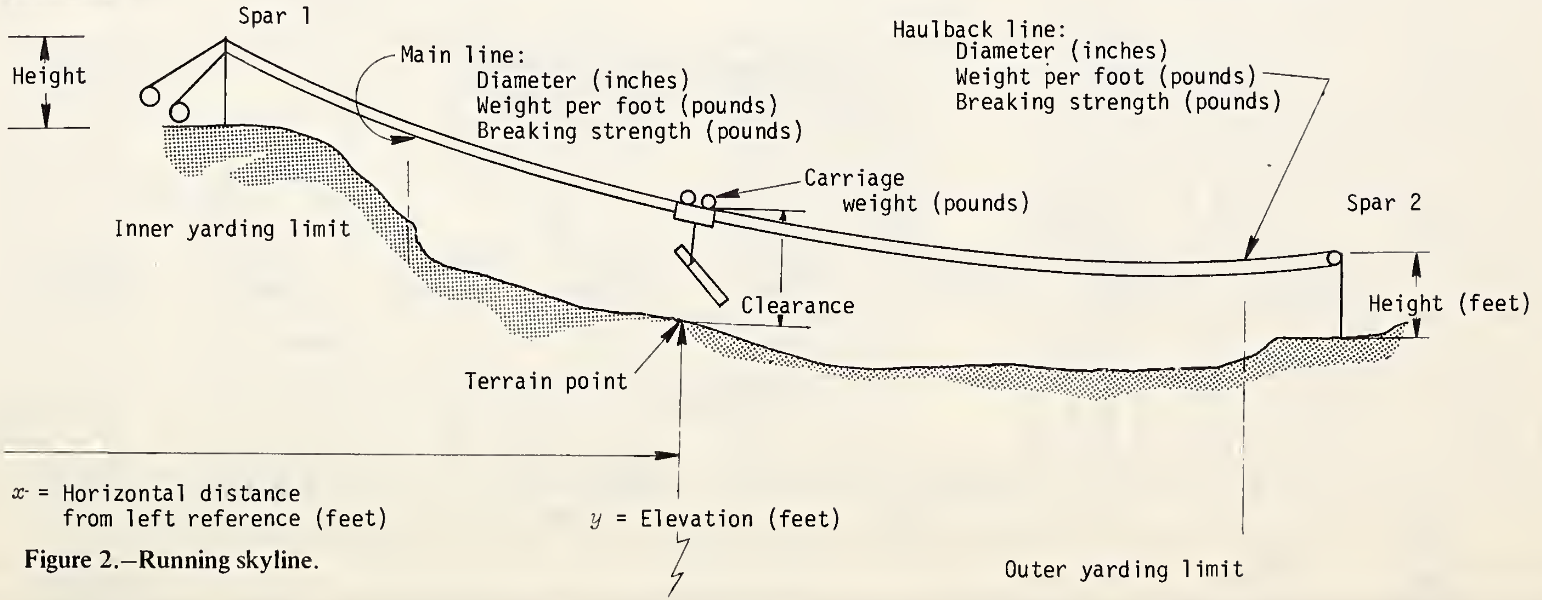


Figure 2.—Running skyline.

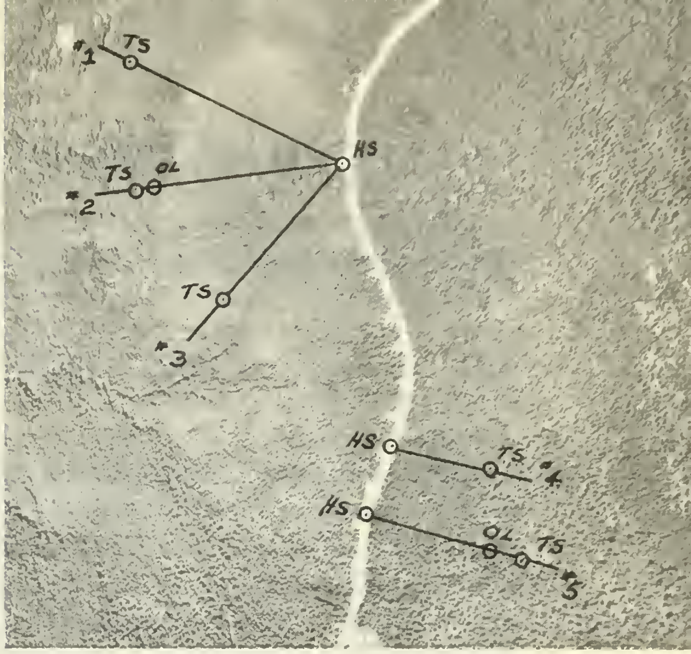


Figure 3.–Aerial photograph positive prepared by the designer.

The last line under "Equipment Data" is for indicators which are used internally by the design programs. These indicators are:

1. Number of skyline roads: the number of skyline roads delineated on the aerial photograph. Each skyline road is described by one set of geometric data.
2. Format of geometric input data: this indication is coded 1 if the terrain data are to be taken from aerial photographs by the procedures discussed in this note.

The height of the headspar, tailspar, and the carriage ground clearance should be indicated in the space provided in the figure.

The aerial photos should include the following information:

1. Each skyline road that is to be investigated must be delineated on the photo and numbered.
2. The locations of the headspar and tailspar for each road should be pinpricked, circled, and labeled HS and TS, respectively.
3. The inner and outer yarding limits, if different from HS and TS, should be circled and labeled IL and OL, respectively.

The lines and labeling are done with transparent, india-type (waterproof), vermilion ink to avoid obscuring details on the photographs (fig. 3).

3.0 OPERATIONAL PROCEDURE--PLOTTER OPERATOR

The stereoplotter operator can prepare the data cards describing the skyline equipment and each skyline road. The general information and equipment specifications are keypunched onto data cards directly from figure 1 or 2 as presented by the designer. The terrain point data are prepared by a Kelsh plotter-digitizer-keypunch system, as discussed in this section.

Glass plates of the photographs submitted by the designer are set up as a stereomodel on the Kelsh plotter, leveled, and scaled to best available control. An individual skyline road, as prepared on the photograph positive by the designer, will appear on the Kelsh plotter manuscript. From the stereomodel, through the digitizer and keypunch, the operator will prepare a lead card and a series of terrain point cards. A definition of the data and card format is discussed in section 4.0. This section should be referenced for definition of terms, data format, and programing of the digitizer. The plotter operator procedure for preparing lead card and terrain point cards for each skyline road is discussed here.

Preparing lead card:

Step 1. Using constants on the digitizer, set up the road number, carriage clearance, headspar height, tailspar height, and card indicator information (format in section 4.0).

Step 2. Locate the headspar, set indicator at 1, and record.

Step 3. Locate the inner yarding limit, set indicator at 1, and record.

Step 4. Locate the outer yarding limit, set indicator at 1, and record.

Step 5. Locate the tailspar, set indicator at 1, and record.

After the lead card is complete, return to start of skyline road to prepare for generating terrain point cards.

Preparing terrain point cards:

Step 1. Reset the card indicator constant on the digitizer to 2.

Step 2. Beginning at the first terrain point, record all prominent terrain points, using a point indicator of 2. On the last terrain point, use a point indicator of 3.

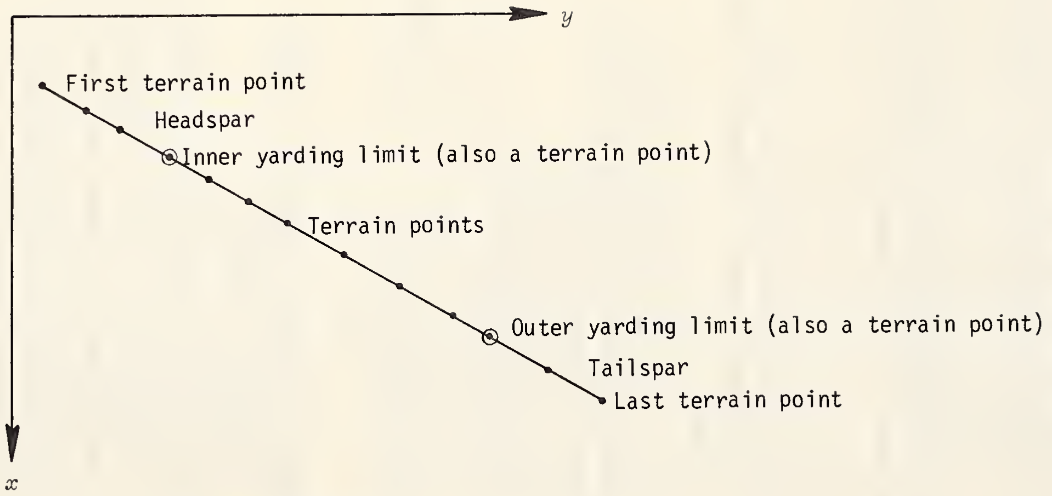
This completes the description of a skyline road. The procedure is repeated for each skyline road in the total layout. These data cards are then placed behind the data cards prepared from figure 1 or 2, and the set can then be submitted for processing by the skyline design computer programs.

4.0 DATA FORMAT--PROCESSING PERSONNEL

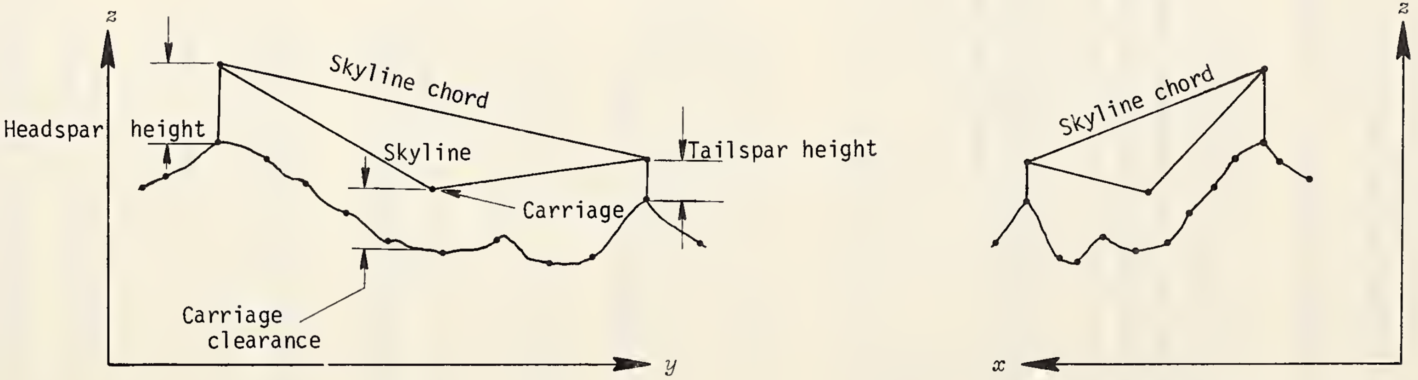
To insure compatibility between the skyline design computer programs and the data input prepared by this procedure, the required information and computer data cards are thoroughly discussed. The patch panel design necessary on an Auto-trol Model 3700 digitizer and the control panel design are shown.

Required information.--A complete description of a skyline road for input to the computer program requires the following information (fig. 4):

Constants:	
Road number	An integer used to identify skyline roads.
Carriage clearance, feet	The vertical distance between carriage and ground required at each terrain point.
Headspar height, feet	The vertical height of the headspar above ground.
Tailspar height, feet	The vertical height of the tailspar above ground.
Locations indicated on the photo:	
Headspar location, feet	The (x,y,z) coordinates of the headspar location.
Inner yarding limit, feet	The (x,y,z) coordinates of the inner yarding limit of the skyline road.
Outer yarding limit, feet	The (x,y,z) coordinates of the outer yarding limit of the skyline road.
Tailspar location, feet	The (x,y,z) coordinates of the tailspar location.
Intermediate terrain points	The (x,y,z) coordinates of the prominent terrain points on the skyline road.


y
First terrain point
Headspar
Inner yarding limit (also a terrain point)
Terrain points
Outer yarding limit (also a terrain point)
Tailspar
Last terrain point
x

xy - Plan view (photo)



yz - Elevation view

xz - Elevation view

Figure 4.—Skyline road geometry.

The designer provides the stereoplotter operator with the constants and the locations indicated on photos for every skyline road. The operator can record this information on data cards through the constant-input knobs and the automatic digitizing features of the digital scaler. The format of these cards and the procedure for developing them are presented here.

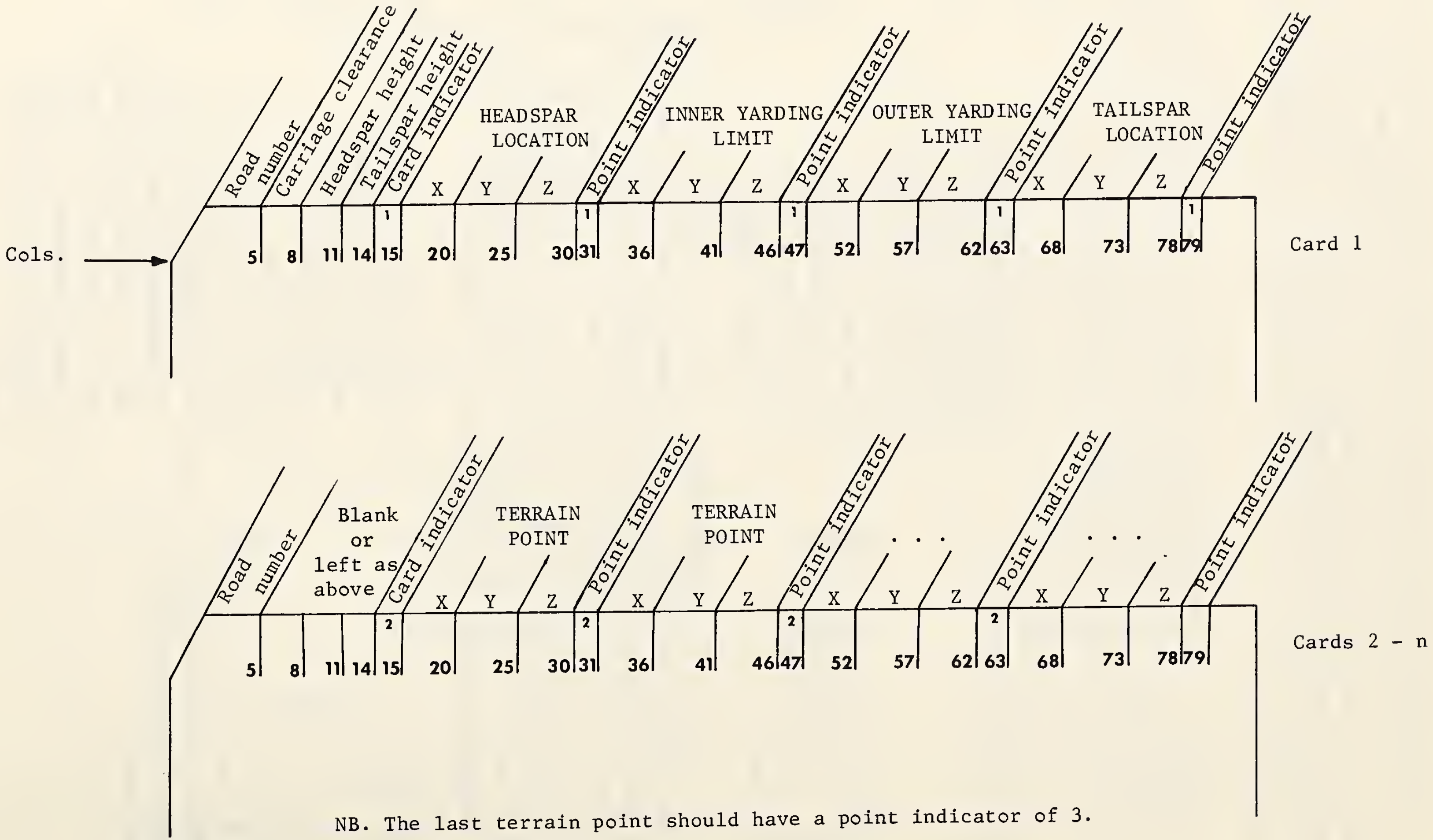
Format.--The required information will be digitized onto one lead card (fig. 5) and as many additional cards as are required to record the intermediate terrain point data. The lead card is arranged as follows (all numbers are right-adjusted integers):

		Columns
Constants: Entered via manual selectors	-Road number	1 - 5
	-Carriage clearance	6 - 8
	-Headspar height	9 - 11
	-Tailspar height	12 - 14
	-Card indicator (set = 1)	15
Locations, (x,y,z) coordinates, and point indicators; automatically recorded	-Headspar location	16 - 31
	-Inner yarding limit	32 - 47
	-Outer yarding limit	48 - 63
	-Tailspar location	64 - 79

The cards following the lead card are used to record intermediate terrain point coordinates. Four sets of (x, y, z) information along with point indicators can be accommodated per card. The first 15 columns, recorded manually on the lead card, can be left the same, except the card indicator in column 15. This should be reset to 2. The point indicators on all intermediate terrain points should be recorded as 2, except the last point. This one should be entered as 3. The format of these terrain cards will be as follows:

		Columns
Constants:	-Road number, carriage clearance, headspar and tailspar height, as in lead card.	1 - 14
	-Card indicator (set = 2)	15
Locations, (x,y,z) coordinates, and point indicators; automatically recorded.	-Starting at first terrain point, record all points in sequence toward tailspar. Use as many cards as are required, and use a point indicator of 3 to indicate the last terrain point.	16 - 79

Figure 5.—Digitizer card format.



NB. The last terrain point should have a point indicator of 3.

Auto-trol Model 3700 Patch Panel

Preparation of the (x,y,z) coordinates by the digitizer into the desired format requires programing. If an Auto-trol Model 3700 digitizer is used, this programing is accomplished with a patch panel as shown in figure 6.

The connections required on this patch panel are given in table 1.

Auto-trol Model 3700 Control Panel

If an Auto-trol Model 3700 digitizer is used, the road number, carriage clearance, headspar height, and tailspar height will be entered through digital constant knobs on the control panel. The control panel is shown in figure 7.

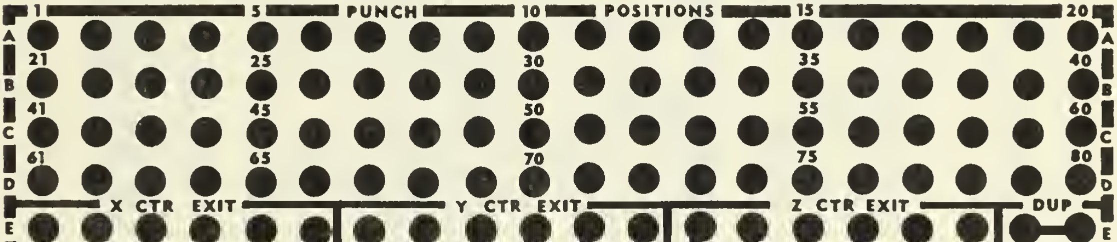


Figure 6.—Auto-trol Model 3700 patch panel.

Table 1.--*Patch panel connections*

Column	is connected to:	Column	is connected to:
1	P1	45	F17
2	N2	46	F18
3	M19	47	K16
4	K4	48	G2
5	K5	49	G3
6	K6	50	G4
7	K7	51	G5
8	K8	52	G6
9	M1	53	G8
10	M2	54	G9
11	M3	55	G10
12	M4	56	G11
13	M5	57	G12
14	M6	58	G14
15	K18	59	G15
16	E2	60	G16
17	E3	61	G17
18	E4	62	G18
19	E5	63	K15
20	E6	64	H2
21	E8	65	H3
22	E9	66	H4
23	E10	67	H5
24	E11	68	H6
25	E12	69	H8
26	E14	70	H9
27	E15	71	H10
28	E16	72	H11
29	E17	73	H12
30	E18	74	H14
31	K17	75	H15
32	F2	76	H16
33	F3	77	H17
34	F4	78	H18
35	F5	79	K14
36	F6	80	F20
37	F8	K13	M7
38	F9	P10	G20
39	F10	N10	H19
40	F11	P5	J12
41	F12	K3	L19
42	F14	P2	K2
43	F15	N1	K1
44	F16	K10	J18

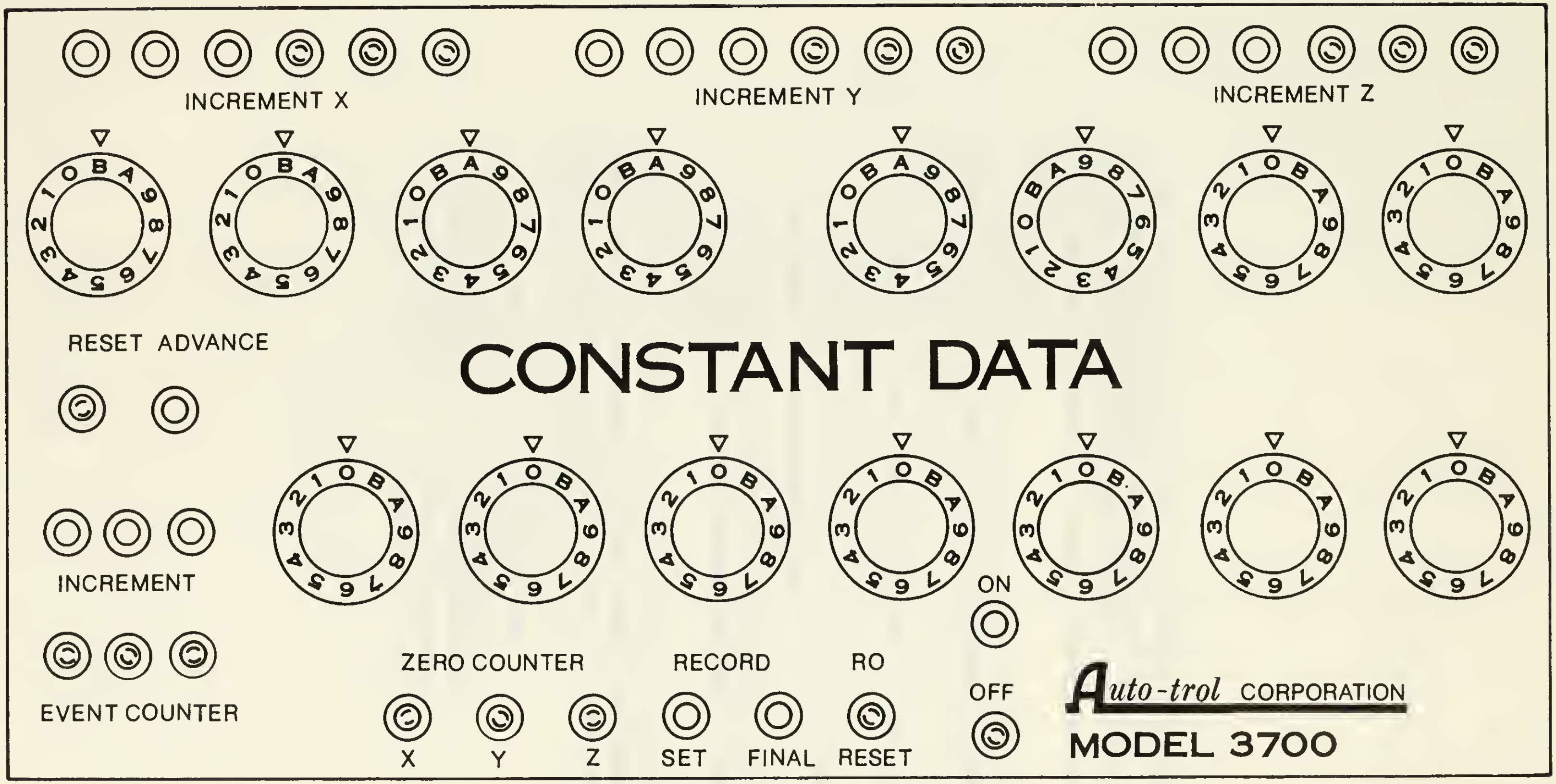


Figure 7.—3700 control panel.

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